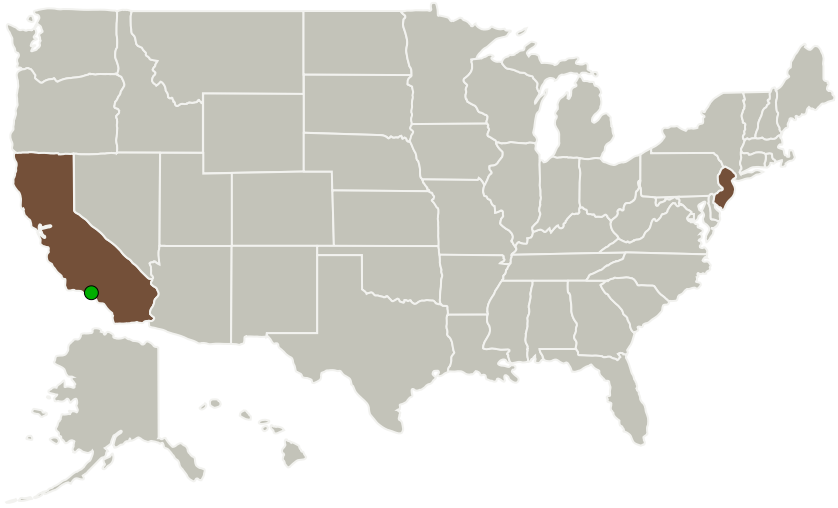
NFAD Arrays for Single Photon Optical Communications at 1.5 um, Phase I

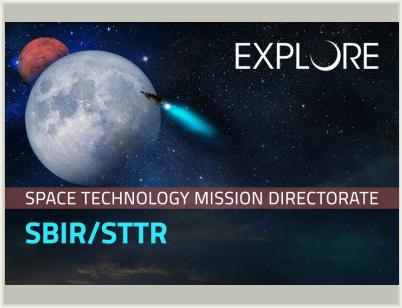
Completed Technology Project (2010 - 2010)

Project Introduction

For this program, we propose to develop large pixel-count single photon counting detector arrays suitable for deployment in spacecraft terminal receivers supporting long-range laser communication systems at 1.5 um. To surmount the present obstacles to higher photon counting rate -- as well as the complexity of back-end circuitry required -- in using conventional single photon avalanche diodes (SPADs), we will leverage initial success in monolithically integrating "negative feedback" elements with state-of-the-art SPADs to beneficially modify the device avalanche dynamics. This approach can achieve extremely consistent passive quenching, and appropriate implementations can lead to rather small avalanches (e.g., ~10^4 ↔ 10^5 carriers), for which reduced carrier trapping provides lower afterpulsing that will no longer limit the photon counting rate. When correctly implemented, this "negative feedback" avalanche diode (NFAD) design is also extremely simple to operate: with just a fixed dc bias voltage, the NFAD will autonomously execute the entire arm, avalanche, quench, and re-arm cycle and generate an output pulse every time an avalanche event is induced. Phase I of this program will be focused on specific pixel-level design advancements related to the reduction of afterpulsing and timing jitter. Along with pixel-level goals, we will also fabricate and characterize test structures to define design and process innovations that guarantee high pixel yield and uniformity on large-scale NFAD arrays. The proof-of-feasibility tasks defined in Phase I will position us to demonstrate space-qualifiable large pixel-count (e.g., 80 x 80) NFAD arrays during a Phase II effort. Design and performance goals have been defined to meet anticipated lasercomm requirements for future space missions.

Primary U.S. Work Locations and Key Partners





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Organizations Performing Work	Role	Type	Location
Princeton Lightwave, Inc.	Lead Organization	Industry	Cranbury, New Jersey
Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations	
California	New Jersey

Project Transitions

January 2010: Project Start

July 2010: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/139969)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Princeton Lightwave, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Mark A Itzler

Co-Investigator:

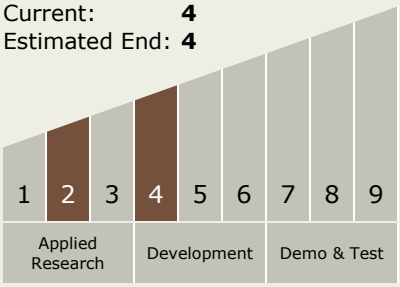
Mark Itzler

NFAD Arrays for Single Photon Optical Communications at 1.5 um, Phase I

Completed Technology Project (2010 - 2010)

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



Technology Areas

Primary:

- TX05 Communications, Navigation, and Orbital Debris Tracking and Characterization Systems
  - TX05.1 Optical Communications
    - TX05.1.1 Detector Development

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System